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530-RSD-WSC	Original	1 September 1996	
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Section 2. Applicable and Reference Documents

2.1 Applicable Documents

The following documents are part of this specification to the extent cited herein. The most recent version of these documents takes precedence. If there are conflicts between the listed documents and the requirements of this specification, the requirements of this specification shall take precedence. In the event of conflict between other listed documents, the order of precedence shall be as follows:

a. The requirements of NASA documents shall take precedence over the requirements of other listed documents.

b. The requirements of other Government documents shall take precedence over contractor documents and industrial standards.

Where no section number is shown, the whole document shall apply.

2.1.1 NASA Documents

Document Number	Document Title
405-F7-ICD-001	TDRS F-7 Interface Control Document for the TDRS Spacecraft/Ground Segment
530-ICD-GRGT-GCF	Interface Control Document between the Guam Remote Ground Terminal (GRGT) and the Ground Communications Facility (GCF)
530-ICD-NCC-FDF/WSC	Interface Control Document (ICD) between the Network Control Center (NCC)/Flight Dynamics Facility (FDF) and the White Sands Complex (WSC)
530-ICD-WSC/SP	Interface Control Document between the White Sands Complex and the Secure Programs Interface Panel.
530-SNUG	Space Network User's Guide, Sections 2.3, 2.4, 2.5, Appendices B, E, and F
530-WSC-LOP	White Sands Complex Local Operating Procedures (LOP), Volume Set
532-FPR-TDF	Functional and Performance Requirements for the Tracking Data Formatter
532-PVP-GRGT	GRGT Performance Verification Plan

Document Number	Document Title
534-OIP-NCC/STGT	Operations Interface Procedures between the Goddard Space Flight Center Network Control Center and the Second TDRSS Ground Terminal
DOD-STD-2167	Defense System Software Development
DOD-STD-2167, STGT Tailored Version	Defense System Software Development, STGT Tailored Version
GA-GEM-1331331	Contractor Administered Training Course, Sections 6, 9, 12
GHB 1600.1A	Goddard Space Flight Center Security Manual
GSFC FDF/552-89/001	Mathematical Theory of the Goddard Trajectory Determination System, Sections 3.2.2, 3.3, 3.4.3, and 3.4.7.
ICD-2-0D004	JSC/GSFC Space Shuttle RF Communications and Tracking, Sections 4.2.1, 4.2.2, 4.2.4, 4.2.6, 4.2.7, and 4.2.8.1
NHB 1620.3A	NASA Security Handbook
NHB 2410.9A	NASA Automated Information Security Handbook
S-323-P-5A	Quality Assurance Requirements for Standard Industrial Equipment
S-530-1	GSFC Specification for Ground System Spare Parts Program
S-572-P-3B	Engineering Drawing Standards and Specifications
SN SCG	Space Network Security Classification Guide
STDN 102	STDN Documentation System
STDN 102.1	Standard for Preparation of STDN Operations Documents
STDN 102.8	Handbook for Interface Control Documents for Non-Project Related Ground Facilities
~~STDN 108~~451-PN CODE-SNIP	~~PN Codes for Use with the Tracking and Data Relay Satellite System (TDRSS)~~Space Network Interoperable PN Code Libraries

g. Provide service performance and equipment status data to the USS ADPE Subsystem and to indicators on the equipment front panels.

h. Provide the baseband/IF/RF signal interface ports to support the Maintenance Test Group (MTG) functions (Section 12).

i. Provide the switching capabilities to support the switching requirements of Figure 5-7:

   (1) Selection of baseband inputs (DIS and PMMS test) into the designated prime and redundant MAF service chains.

   (2) Selection of distribution (RF Power Combiner, PMMS or dummy load) of RF service chain outputs.

j. Support customer tracking services and time transfer, as scheduled, by providing the forward PN code epoch and PN clock to the USS tracking equipment.

5.3.1.3 Performance Requirements

The performance requirements for SAF and MAF service support are divided as follows:

a. SSAF Equipment.

b. KSAF Equipment.

c. MAF Equipment.

5.3.1.3.1 SSAF Equipment

The performance of the SSAF equipment shall be as specified below.

5.3.1.3.1.1 Signal Parameters

The SSAF service chain shall provide a signal with parameters as specified in Tables 5-9 (SSAF) and 5-10 (SSHF).

5.3.1.3.1.2 Forward Signal Constraints

The SSAF service chain shall provide a SSAF signal which meets the signal constraint requirements of Table 5-11; these characteristics are defined at the output of the USS.

5.3.1.3.1.3 Additional SSAF Signal Requirements

The SSAF service chain, in conjunction with the Antenna Subsystem shall satisfy the additional performance requirements of Table 5-12.

Table 5-9. SSAF Service Signal Parameters

A. RATIO OF COMMAND CHANNEL POWER TO RANGE CHANNEL POWER	10 dB
B. RANGE CHANNEL	
1. CARRIER FREQUENCY	COMMAND CHANNEL CARRIER FREQUENCY DELAYED $\pi/2$ RADIANS
2. PN MODULATION	PSK, $\pm \pi/2$ RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CHIP RATE	$\frac{31}{221 \times 96} \times K_F$ SYNCHRONOUS WITH COMMAND CHANNEL PN CODE CHIP RATE ($\approx$ 3M CHIPS/SEC)
5. PN CODE LENGTH	$(2^{10}-1) \times 256$ CHIPS
6. PN CODE EPOCH REFERENCE	PN CODE EPOCH (ALL 1'S CONDITION) SYNCHRONIZED TO THE COMMAND CHANNEL PN CODE EPOCH
7. PN CODE FAMILY	TRUNCATED 18-STATE SHIFT REGISTER SEQUENCES; PER ~~STDN NO.108~~451-PN CODE-SNIP
C. COMMAND CHANNEL	
1. CARRIER FREQUENCY	SGLT TRANSMIT CARRIER FREQUENCY
2. PN MODULATION	PSK, $\pm \pi/2$ RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CODE LENGTH	$2^{10}-1$ CHIPS
5. PN CODE FAMILY	GOLD CODES; PER ~~STDN NO.108~~451-PN CODE SNIP
6. PN CHIP RATE[1] (CHIPS/SEC)	$\frac{31}{221 \times 96} \times K_F$ ($\approx$ 3M CHIPS/SEC)
7. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
8. DATA RATE[2]	0.1 TO 300 kbps
9. DATA MODULATION	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE

NOTES

[1] K_F IS THE TDRS-TO-CUSTOMER FREQUENCY.

$$2200 \text{ MHz} \left(\frac{221}{240}\right) \leq K_F \leq 2300 \text{ MHz} \left(\frac{221}{240}\right)$$

[2] THE SSAF SERVICE CHAIN SHALL BE CAPABLE OF ACCOMMODATING ANY CHANGE TO THE ACTUAL INPUT DATA RATE WITHOUT THE SGLT BEING NOTIFIED OF THE CHANGE BY THE NCC.

Table 5-10. SSHF Service Signal Parameters

A. DATA RATE	MODE 1: 32 kbps; MODE 2: 72 kbps
B. CONVOLUTIONAL CODING	NRZ-L INPUT DATA SHALL BE CONVOLUTIONALLY ENCODED IN MODES 1 & 2
C. CODE RATE	1/3
D. CONSTRAINT LENGTH	7
E. GENERATOR FUNCTIONS	G_1: 1111001; G_2: 1011011; G_3: 1100101
F. DATA FORMAT	ENCODED DATA SHALL BE CONVERTED TO BIPHASE-L FORMAT
G. DATA MODULATION[1]	BIPHASE-L SYMBOLS SHALL BE MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE
H. PN CHIP RATE[2]	11.232 MCHIPS PER SECOND, TUNABLE OVER ± 0.1%
I. PN CODE LENGTH	1023 CHIPS
J. CARRIER MODULATION	PSK, ± π /2 RADIANS
K. CARRIER SUPPRESSION	30 dB, MINIMUM
L. PN CODE FAMILY	PER ~~STDN 108~~451-PN CODE-SNIP

NOTES

[1]WHEN THE DATA CLOCK SIGNAL IS CLAMPED TO A LOGICAL-1 STATE, THE CARRIER SHALL CONTAIN NO DATA MODULATION. WHEN THE COMMAND CHANNEL PN MODULATION IS INHIBITED THE DATA SHALL DIRECTLY BPSK MODULATE THE TRANSMITTED CARRIER ± π /2 RADIANS.

[2]SHUTTLE PN CHIP RATE AND CARRIER FREQUENCY ARE INDEPENDENT. PN CHIP RATE AND CARRIER FREQUENCY SHALL BE AS SCHEDULED. CAPABILITY TO INDEPENDENTLY DOPPLER COMPENSATE THE PN CHIP RATE AND CARRIER FREQUENCY AND TO INDEPENDENTLY INHIBIT DOPPLER COMPENSATION SHALL BE PROVIDED.

Table 5-11. Signal Constraint Requirements for SSAF Service Equipment[1]

PARAMETER	REQUIREMENT
A. COMMAND CHANNEL RADIATED POWER RANGE CHANNEL RADIATED POWER	10 ± 0.5 dB
B. MODULATOR GAIN IMBALANCE (PEAK)	± 0.25 dB
C. RELATIVE PHASE BETWEEN COMMAND AND RANGE CHANNELS (PEAK)	90 ± 3°
D. DATA ASYMMETRY (PEAK)[2]	± 3%
E. DATA TRANSITION TIME (90% OF INITIAL STATE TO 90% OF FINAL STATE)[2]	≤ 5% OF DATA BIT DURATION
F. PHASE NONLINEARITY (PEAK), BEST STRAIGHT LINE (BSL)	± 4.25° OVER ± 7.0 MHz
G. GAIN FLATNESS (PEAK), RSS	± 0.4 dB OVER ± 7.0 MHz
H. GAIN SLOPE (PEAK)	± 0.1 dB/MHz OVER ± 7.0 MHz

Table 5-11. Signal Constraint Requirements for SSAF Service Equipment[1] (Continued)

I. AM/AM	≥ 0.0 AND ≤ 1.0 dB/dB
J. AM/PM	≤5°/dB
K. PN CODE CHIP JITTER (RMS) (INCLUDING EFFECTS OF DOPPLER COMPENSATION)	≤1°
L. DATA BIT JITTER (PEAK)[2]	≤1%
M. SPURIOUS PM (RMS)	≤ 0.8° OVER ± 10.0 MHz
N. SPURIOUS OUTPUTS (SUM OF ALL IN-BAND SPURS FROM ALL TRANSMIT SOURCES)	≥30 dBc OVER ± 10.0 MHz
O. INCIDENTAL AM (PEAK)[3] (EXCLUDING TWT HPA IONIC RELAXATION PULSES)	≤1.5% OVER ± 10.0 MHz
P. PHASE NOISE (RMS) - TOTAL 1 Hz - 10 Hz 10 Hz - 32 Hz 32 Hz - 1 kHz 1 kHz - 10 MHz	 ≤1.4° ≤1.4° ≤3.9° ≤1.0°
Q. PHASE NOISE (RMS) - COMPONENT NOT COHERENT WITH TTCS PILOT SIGNAL 1 Hz - 10 Hz 10 Hz - 32 Hz 32 Hz - 1 kHz 1 kHz - 10 MHz	 ≤ 0.8° ≤ 0.7° ≤ 1.8° ≤ 1.0°
R. COMMAND/RANGE CHANNEL PN CODE CHIP SKEW (PEAK)	≤ 0.01 CHIP
S. PN CODE CHIP ASYMMETRY (PEAK)	≤ 0.01 CHIP
T. PN CODE CHIP RATE (PEAK) RELATIVE TO ABSOLUTE COHERENCE WITH CARRIER RATE	≤ 0.01 CHIPS/SEC AT PN CODE CHIP RATE

NOTES

[1]SIGNAL CONSTRAINT DEFINITIONS ARE PROVIDED IN 530-SNUG (APPENDIX E).

[2]THESE VALUES ARE THE SGLT CONTRIBUTIONS TO DATA ASYMMETRY, DATA TRANSITION TIME, AND DATA BIT JITTER, ASSUMING PERFECT FORWARD SERVICE USS INPUT DATA.

[3]INCIDENTAL AM PULSES DUE TO TWT HPA IONIC RELAXATION SHALL BE LESS THAN 10 MILLISECONDS IN DURATION AND 1.5% (PEAK) IN AMPLITUDE. THEREFORE, THE WORST CASE TOTAL VALUE FOR INCIDENTAL AM WILL BE LESS THAN 3% (PEAK).

3. Data Presence Monitoring. Continuously monitor the data and clock channels to determine:

   (a) Clock Presence.

   (b) Data Transition Density.

b. Front Panel Capabilities. To support the MTG requirements, all equipment, down to the LRU level, shall incorporate front panel controls, status indicators, and test and monitoring points including:

   1. Visual on/off status indication.

   2. Visual prime-redundant status indication.

   3. Access to input/output baseband, IF and RF signals and selected voltage levels.

   4. All status provided to the USS ADPE Subsystem.

   5. ON/OFF controls.

   6. Test mode selects.

c. BIT/BITE Monitoring. Provide BIT/BITE monitoring data to the USS ADPE Subsystem.

5.3.1.3.2 KSAF Equipment

The performance of the KSAF equipment shall be as specified below.

5.3.1.3.2.1 Signal Parameters

The KSAF service chain shall provide a forward link signal with the signal parameters as specified in Tables 5-16 (KSAF) and 5-17 (KSHF).

Table 5-16. KSAF Service Signal Parameters

A. RATIO OF COMMAND CHANNEL POWER TO RANGE CHANNEL POWER	10 dB
B. RANGE CHANNEL[1]	
1. CARRIER FREQUENCY	COMMAND CHANNEL CARRIER FREQUENCY DELAYED $\pi/2$ RADIANS
2. PN MODULATION	PSK, $\pm \pi/2$ RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CHIP RATE	$\frac{31}{1469 \times 96} \times K_F$ SYNCHRONOUS WITH COMMAND CHANNEL PN CODE CHIP RATE ($\approx$ 3M CHIPS/SEC)
5. PN CODE LENGTH	$(2^{10}-1) \times 256$ CHIPS

Table 5-16. KSAF Service Signal Parameters (Continued)

6. PN CODE EPOCH REFERENCE	ALL 1'S CONDITION SYNCHRONIZED TO THE COMMAND CHANNEL PN CODE EPOCH
7. PN CODE FAMILY	TRUNCATED 18-STAGE SHIFT REGISTER SEQUENCES; PER ~~STDN No. 108~~451-PN CODE-SNIP
C. COMMAND CHANNEL	
1. CARRIER FREQUENCY	SGLT TRANSMIT CARRIER FREQUENCY
2. PN MODULATION[2]	PSK, ± π /2 RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CODE LENGTH	2^{10}-1 CHIPS
5. PN CODE FAMILY	GOLD CODES; PER ~~STDN No. 108~~451-PN CODE SNIP
6. PN CHIP RATE[3] (CHIPS/SEC)	$\frac{31}{1469 \times 96} \times K_F$ (≈ 3M CHIPS/SEC)
7. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
8. DATA RATE[5]	1 kbps TO 25 Mbps
9. DATA MODULATION	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE

NOTES

[1]FOR DATA RATES > 300 kbps, THE RANGE CHANNEL SHALL BE INHIBITED.

[2]THE COMMAND CHANNEL PN MODULATION SHALL BE INHIBITED FOR DATA RATES EXCEEDING 300 kbps.

[3]K_F IS THE TDRS TO CUSTOMER FREQUENCY. K_F = 13.775 ± 0.7 MHz.

[4]WHEN THE DATA CLOCK SIGNAL IS CLAMPED TO A LOGICAL-1 STATE, THE CARRIER SHALL CONTAIN NO DATA MODULATION. WHEN THE COMMAND CHANNEL PN MODULATION IS INHIBITED THE DATA SHALL DIRECTLY BPSK MODULATE THE TRANSMITTED CARRIER ± π /2 RADIANS.

[5]FOR DATA RATES LESS THAN 300 kbps, THE KSAF SERVICE CHAIN SHALL BE CAPABLE OF ACCOMMODATING ANY CHANGE TO THE ACTUAL INPUT DATA RATE WITHOUT THE SGLT BEING NOTIFIED OF THE CHANGE BY THE NCC.

Table 5-17. KSHF Service Signal Parameters

A. PN MODULATION[2]	PSK, ± π /2 RADIANS
B. CARRIER SUPPRESSION	30 dB MINIMUM
C. PN CODE LENGTH	2^{10} -1 CHIPS
D. PN CODE FAMILY	GOLD CODES; PER ~~STDN No. 108~~451-PN CODE-SNIP
E. PN CHIP RATE[3]	$\frac{31}{1469 \times 96} \times K_F$ (≈ 3M CHIPS/SEC)

Table 5-21. KSAF IF Output Port (Unmodulated IF)

A. FREQUENCY	370 MHz
B. OUTPUT IMPEDANCE	50 OHMS
C. VSWR	1.3:1 MAX, OVER 370 MHz ± 2.5 MHz
D. OUTPUT SIGNAL LEVEL	-15 dBM, ± 3 dB
E. SPURIOUS SIGNALS: SUM OF ALL SPURIOUS SIGNALS WITHIN OPERATING BANDWIDTH INDIVIDUAL SPURIOUS SIGNALS	≥ 30 dB BELOW DESIRED SIGNAL ≥ 40 dB BELOW DESIRED SIGNAL

Table 5-22. KSAF IF Input Port (Modulated IF)

A. CENTER FREQUENCY	370 MHz
B. INPUT BANDWIDTH (MINIMUM)	50 MHz
C. INPUT IMPEDANCE	50 OHMS
D. VSWR	1.3:1 MAX, OVER 370 MHz ± 20 MHz
E. INPUT SIGNAL LEVEL	-10 dBM, ± 3 dB
F. SPURIOUS SIGNALS: SUM OF ALL SPURIOUS SIGNALS WITHIN OPERATING BANDWIDTH INDIVIDUAL SPURIOUS SIGNALS	≥ 30 dB BELOW DESIRED SIGNAL ≥ 40 dB BELOW DESIRED SIGNAL

5.3.1.3.2.6 Performance Measuring and Monitoring Support

a. Status Measuring and Monitoring. During service, the KSAF equipment shall provide equipment and service performance status data to the USS ADPE Subsystem every second. This data shall include the following:

1. Service Performance Parameters.

(a) PN Modulation.

(b) Carrier Frequency.

(c) Customer Command/Range Channel Power.

2. Equipment Status.

(a) Power Supply Status.

(b) Power Settings.

3. Data Presence Monitoring. Continuously monitor the data and clock channels to determine:

(a) Clock Presence.

(b) Data Transition Density.

b. Format Panel Capabilities. To support the MTG requirements, all equipment, down to the LRU level, shall incorporate front panel controls, status indicators, and test and monitoring points that include:

1. Visual on/off status indication.
2. Visual prime-redundant status indication.
3. Access to input/output baseband, IF and RF signals and selected voltage levels.
4. All status provided to the USS ADPE Subsystem.
5. ON/OFF Controls.
6. Test mode selects.

c. BIT/BITE Monitoring. Provide BIT/BITE monitoring data to the USS ADPE Subsystem.

5.3.1.3.3 MAF Equipment

The performance of the MAF equipment shall be as specified below.

5.3.1.3.3.1 Signal Parameters

The MAF service chain shall provide a signal with parameters as specified in Table 5-23.

Table 5-23. MAF Service Signal Parameters

A. RATIO OF COMMAND CHANNEL POWER TO RANGE CHANNEL POWER	10 dB
B. RANGE CHANNEL	
1. CARRIER FREQUENCY	COMMAND CHANNEL CARRIER FREQUENCY DELAYED $\pi/2$ RADIANS
2. PN MODULATION	PSK, $\pm \pi/2$ RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CHIP RATE	$\frac{31}{221 \times 96} \times K_F$ ($\approx$ 3M CHIPS/SEC) SYNCHRONOUS WITH COMMAND CHANNEL PN CODE CHIP RATE
5. PN CODE LENGTH	$(2^{10} - 1) \times 256$ CHIPS
6. PN CODE EPOCH REFERENCE	PN CODE EPOCH (ALL 1'S CONDITION) SYNCHRONIZED TO THE COMMAND CHANNEL PN CODE EPOCH
7. PN CODE FAMILY	TRUNCATED 18-STAGE SHIFT REGISTER SEQUENCES; PER ~~STDN 108~~451-PN CODE-SNIP

Table 5-23. MAF Service Signal Parameters (Continued)

C. COMMAND CHANNEL	
1. CARRIER FREQUENCY	SGLT TRANSMIT CARRIER FREQUENCY
2. PN MODULATION	PSK, ± π/2 RADIANS
3. CARRIER SUPPRESSION	30 dB MINIMUM
4. PN CODE LENGTH	2^{10} -1 CHIPS
5. PN CODE FAMILY	GOLD CODES; PER ~~STDN 108~~451-PN CODE-SNIP
6. PN CHIP RATE[1] (CHIPS/SEC)	$\frac{31}{221x96}$ x K_F (≈ 3M CHIPS/SEC)
7. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
8. DATA RATE[2]	0.1 TO 10 kbps
9. DATA MODULATION	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE

NOTES

[1] K_F IS THE TDRS-TO-CUSTOMER FREQUENCY. $K_F = 2287.5 \pm 0.1$ MHz $\left(\frac{221}{240}\right)$

[2] THE MAF SERVICE CHAIN SHALL BE CAPABLE OF ACCOMMODATING ANY CHANGE TO THE ACTUAL INPUT DATA RATE WITHOUT THE SGLT BEING NOTIFIED OF THE CHANGE BY THE NCC.

5.3.1.3.3.2 Forward Signal Constraints

The MAF service chain shall provide a MAF signal which meets the signal constraint requirements of Table 5-24; these characteristics are defined at the output of the USS.

Table 5-24. Signal Constraint Requirements for MAF Service Equipment[1]

PARAMETER	REQUIREMENT
A. COMMAND CHANNEL RADIATED POWER RANGE CHANNEL RADIATED POWER	10 ± 0.5 dB
B. MODULATOR GAIN IMBALANCE (PEAK)	± 0.25 dB
C. RELATIVE PHASE BETWEEN COMMAND AND RANGE CHANNELS (PEAK)	90 ± 3°
D. DATA ASYMMETRY (PEAK)[2]	± 3%
E. DATA TRANSITION TIME (90% OF INITIAL STATE TO 90% OF FINAL STATE)[2]	≤ 5% OF DATA BIT DURATION
F. PHASE NONLINEARITY (PEAK), BEST STRAIGHT LINE (BSL)	± 4.25° OVER ± 2.1 MHz

Table 5-24. Signal Constraint Requirements for MAF Service Equipment[1] (Cont'd)

G. GAIN FLATNESS (PEAK), RSS	± 0.4 dB OVER ± 2.1 MHz
H. GAIN SLOPE (PEAK)	± 0.1 dB/MHz OVER ± 2.1 MHz
I. AM/AM	≥ 0.0 AND ≤ 1.0 dB/dB
J. AM/PM	≤ 4°/dB
K. PN CODE CHIP JITTER (RMS) (INCLUDING EFFECTS OF DOPPLER COMPENSATION)	≤ 1°
L. DATA BIT JITTER (PEAK)[2]	≤ 1%
M. SPURIOUS PM (RMS)	≤ 0.8° OVER ± 3.0 MHz
N. SPURIOUS OUTPUTS (SUM OF ALL IN-BAND SPURS FROM ALL TRANSMIT SOURCES)	≥ 30 dBc OVER ± 3.0 MHz
O. INCIDENTAL AM (PEAK)	≤ 1.4% OVER ± 3.0 MHz
P. PHASE NOISE (RMS) - TOTAL 1 Hz - 10 Hz 10 Hz - 32 Hz 32 Hz - 1 kHz 1 Hz - 3 MHz	 ≤ 1.4° ≤ 1.4° ≤ 3.9° ≤ 1.0°
Q. PHASE NOISE (RMS) - COMPONENT NOT COHERENT WITH TTCS PILOT SIGNAL 1 Hz - 10 Hz 10 Hz - 32 Hz 32 Hz - 1 kHz 1 kHz - 3 MHz	 ≤ 0.8° ≤ 0.7° ≤ 1.8° ≤ 1.0°
R. COMMAND/RANGE CHANNEL PN CODE CHIP SKEW (PEAK)	≤ 0.01 CHIP
S. PN CODE CHIP ASYMMETRY (PEAK)	≤ 0.01 CHIP
T. PN CODE CHIP RATE (PEAK) RELATIVE TO ABSOLUTE COHERENCE WITH CARRIER RATE	≤ 0.01 CHIPS/SEC AT PN CODE CHIP RATE

NOTES

[1]SIGNAL CONSTRAINT DEFINITIONS ARE PROVIDED IN 530-SNUG, (APPENDIX E).

[2]THESE VALUES ARE THE SGLT CONTRIBUTIONS TO DATA ASYMMETRY, DATA TRANSITION TIME, AND DATA BIT JITTER, ASSUMING PERFECT FORWARD SERVICE USS INPUT DATA.

9. Clamp the data output (I and Q channel independently for dual data channel operation) to a logical-1 when there is detected loss of data in the channel.

10. During times when a data channel is clamped to a logical-1 due to a loss of data, provide a data clock output signal whose rate is within five percent of the scheduled rate.

11. Provide service performance and equipment status data to the USS ADPE Subsystem and provide status indicators on the equipment front panels.

12. Provide the following signal interface ports:

    (a) Baseband/IF/RF signal interface ports to support MTG functions.

13. Continuously monitor the service chain baseband output data for frame sync (during a scheduled service) and report the sync status to the USS ADPE Subsystem. The requirements for data quality monitoring are described in Appendix B.

14. Provide the switching capability to support the switching requirements of Figure 5-14.

    (a) Selection of RF inputs (RF Power Divider or PMMS test) into the MAR service equipment.

    (b) Selection of destination (DIS or PMMS) of the baseband data output from the MAR Signal Processors.

5.3.2.3 Performance Requirements

The performance requirements for SAR equipment are divided as follows:

a. SSAR Equipment.

b. KSAR Equipment.

c. MAR Equipment.

5.3.2.3.1 SSAR Equipment

The performance of the SSAR equipment shall be as specified below.

5.3.2.3.1.1 Signal Parameters

The SSAR service equipment shall be capable of supporting a return link signal with the parameters as specified in Table 5-29 (SSAR) and Table 5-30 (SSHR).

Table 5-29. SSAR Service Signal Parameters

A. DATA GROUP 1 (DG1)[1]	
1. CUSTOMER CARRIER FREQUENCY (F_1)[2] MODES 1 AND 3 MODE 2[8]	$\frac{240}{221} \times F_R$ CUSTOMER SPACECRAFT OSCILLATOR
2. PN CODE MODULATION MODES 1 AND 2 MODE 3, I CHANNEL	 SQPN PSK, $\pm \pi/2$ RADIANS
3. PN CHIP RATE (CHIPS/SEC)	$\frac{31}{240 \times 96} \times F_1$ ($\approx$ 3M CHIPS/SEC)
4. PN CODE LENGTH (CHIPS) MODES 1 AND 3 MODE 2	 $(2^{10} - 1) \times 256$ $2^{11} - 1$
5. PN CODE EPOCH REFERENCE MODE 1 I CHANNEL Q CHANNEL[3] MODE 2 I CHANNEL Q CHANNEL MODE 3, I CHANNEL	 EPOCH (ALL 1'S CONDITION) SYNCHRONIZED TO EPOCH (ALL 1'S CONDITION) OF CUSTOMER SPACECRAFT RECEIVED FORWARD SERVICE RANGE CHANNEL PN CODE EPOCH DELAYED X + 1/2 PN CHIPS RELATIVE TO I CHANNEL PN CODE EPOCH CUSTOMER SPACECRAFT OSCILLATOR EPOCH DELAYED 1/2 PN CODE CHIP PERIOD RELATIVE TO I CHANNEL PN CODE EPOCH SAME AS MODE 1 (I CHANNEL)
6. PN CODE FAMILY MODES 1 AND 3 MODE 2	 TRUNCATED 18 STAGE SHIFT REGISTER SEQUENCES; PER ~~STDN 108~~451-PN CODE-SNIP GOLD CODES; PER ~~STDN 108~~451-PN CODE-SNIP
7. SYMBOL INTERLEAVING[4]	530-SNUG (APPENDIX F)
8. SYMBOL FORMAT[7]	NRZ, Bi ϕ -L
9. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
10. DATA MODULATION MODES 1 AND 2 MODE 3 I CHANNEL Q CHANNEL	 MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE ON EACH CHANNEL; SQPN MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE PSK $\pm \pi/2$ RADIANS

Table 5-29. SSAR Service Signal Parameters (Continued)

11. MODE 1 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 0.1-300 kbps 0.1-150 kbps 0.1-150 kbps
12. MODE 2 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 1-300 kbps 1-150 kbps 1-150 kbps
13. MODE 3 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 I (MAX) + Q (MAX) 0.1-150 kbps 1 kbps - 3 Mbps
B. DATA GROUP 2[1]	
1. CUSTOMER CARRIER FREQUENCY (F_2) COHERENT MODE (MODE 1)	$\frac{240}{221} \times F_R$
NONCOHERENT MODE (MODE 2)[8]	CUSTOMER SPACECRAFT OSCILLATOR
2. SYMBOL FORMAT[7]	NRZ, Biϕ– L
3. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
4. DATA RATE RESTRICTIONS[5,6] TOTAL I CHANNEL Q CHANNEL	 I (MAX) + Q(MAX) 1 kbps - 3 Mbps 1 kbps - 3 Mbps
5. DATA MODULATION	SQPSK, BPSK (SINGLE DATA CHANNEL), OR QPSK (DUAL DATA CHANNEL)
6. SYMBOL INTERLEAVING[4]	530-SNUG (APPENDIX F)

NOTES

[1]THE CUSTOMER SPACECRAFT DATA CONFIGURATIONS ARE DEFINED IN SECTION 5.3.2.3.1.3.

[2]F_R IS THE CARRIER FREQUENCY ARRIVING AT THE CUSTOMER SPACECRAFT; EXCEPT DURING SCHEDULED PERIODS OF DOPPLER COMPENSATION INHIBIT, $F_R = f_o \pm E$, WHERE f_o EQUALS THE NOMINAL CENTER FREQUENCY OF THE CUSTOMER SPACECRAFT RECEIVER AS DEFINED IN THE SCHEDULE AND $E = 70 \times \ddot{R}$ WHERE $\ddot{R} \leq 50$ m/sec^2.

[3]Q CHANNEL PN CODE IS IDENTICAL TO I CHANNEL PN CODE OFFSET x + 1/2 PN CHIPS, WHERE $x \geq 20{,}000$. VALUE OF x IS DETERMINED BY PN CODE ASSIGNMENTS FOR A PARTICULAR CUSTOMER SPACECRAFT (~~STDN 108~~451-PN CODE-SNIP).

[4]FOR DG1, SYMBOL INTERLEAVING SHALL BE APPLICABLE ONLY TO THE DG1 MODE 3 Q CHANNEL. SYMBOL INTERLEAVING SHALL BE APPLICABLE ONLY FOR SYMBOL RATES EXCEEDING 300 ksps.

Table 5-29. SSAR Service Signal Parameters (Continued)

NOTES (CONT'D)

[5]DATA SIGNALS ON I AND Q CHANNELS MAY BE INDEPENDENT AND ASYNCHRONOUS. IF THE I AND Q CHANNEL DATA SIGNALS ARE INDEPENDENT, THE SUM OF THE DATA RATES ON THE I AND Q CHANNEL SHALL NOT EXCEED THE TOTAL MAXIMUM DATA RATE. FOR DATA GROUP 2 DUAL CHANNEL WITH IDENTICAL SYMBOL RATES ON THE I AND Q CHANNELS, THE I AND Q CHANNELS WILL BE OFFSET RELATIVE TO ONE ANOTHER BY ONE HALF SYMBOL PERIOD. WHEN BI-PHASE FORMAT CONVERSION IS USED, THE MAXIMUM DATA RATES FOR THE I CHANNEL, THE Q CHANNEL, AND THE TOTAL ARE REDUCED BY A FACTOR OF 2. FOR DG2, THE MAXIMUM DATA RATES FOR THE I AND Q CHANNELS ARE REDUCED BY A FACTOR OF 1.5 WHEN DATA IS RATE 1/3 CONVOLUTIONALLY CODED, OR A FACTOR OF 3 WHEN BOTH RATE 1/3 CODING AND BI-ϕ FORMAT CONVERSION ARE USED. WHEN THE DECODING OPERATION IS BYPASSED, THE MAXIMUM DATA RATE FOR THE Q-CHANNEL AND FOR THE I-CHANNEL IS 300 kbps FOR DG1 AND 6 Mbps FOR DG2.

[6]FOR SQPSK OPERATION, WITH IDENTICAL SYMBOL RATES AND POWER LEVELS ON THE I AND Q CHANNELS, THE MINIMUM RECEIVED C/N_0, AT THE LNA OUTPUT, SHALL EXCEED 48 dB-Hz.

[7]WHEN SYMBOL INTERLEAVING IS NOT UTILIZED, THE TRANSMITTED SYMBOL FORMAT MAY BE NRZ-TO-BI ϕ -L CONVERTED, IN WHICH CASE THERE SHALL BE NO G_2 INVERSION.

[8]MODE 2A DENOTES MODE 2 WHEN THE CUSTOMER SPACECRAFT OSCILLATOR FREQUENCY UNCERTAINTY IS LESS THAN ± 700 Hz; MODE 2B DENOTES THE CASE WHEN THE UNCERTAINTY IS LESS THAN ± 3 kHz.

Table 5-30. SSHR Service Signal Parameters

A. DATA RATE	MODE 1 - 96 kbps MODE 2 - 192 kbps MODE 3 - CARRIER ONLY; THE RETURN FORWARD LINK CARRIER
B. CARRIER MODULATION	BPSK, ± π /2 RADIANS
C. DATA CODING	CONVOLUTIONAL; RATE 1/3; CONSTRAINT LENGTH 7 G_1: 1111001 G_2: 1011011 G_3: 1100101
D. DATA FORMAT	NRZ-L
E. SYMBOL FORMAT	Bi ϕ -L

Table 5-39. KSAR Service Signal Parameters (Continued)

Q CHANNEL[3]	EPOCH DELAYED X + 1/2 PN CHIPS RELATIVE TO I CHANNEL PN CODE EPOCH
MODE 2	CUSTOMER SPACECRAFT TRANSMITTER OSCILLATOR
I CHANNEL Q CHANNEL	EPOCH DELAYED 1/2 PN CODE CHIP PERIOD RELATIVE TO I CHANNEL PN CODE EPOCH
MODE 3 I CHANNEL	SAME AS MODE 1 (I CHANNEL)
6. PN CODE FAMILY MODES 1 AND 3	TRUNCATED 18 STAGE SHIFT REGISTER SEQUENCES; PER ~~STDN NO. 108~~451-PN CODE-SNIP
MODE 2	GOLD CODES; PER ~~STDN NO. 108~~451-PN CODE-SNIP
7. DATA FORMAT WITHOUT CONVOLUTIONAL CODING WITH CONVOLUTIONAL CODING[4]	 NRZ-L, NRZ-M, NRZ-S, Biϕ-L, Biϕ-M, Biϕ-S NRZ-L, NRZ-M, NRZ-S
8. DATA MODULATION MODES 1 AND 2	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE ON EACH CHANNEL; SQPN
MODE 3 I CHANNEL	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE
Q CHANNEL	PSK ± π/2 RADIANS
9. MODE 1 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 1-600 kbps 1-300 kbps 1-300 kbps
10. MODE 2 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 1-600 kbps 1-300 kbps 1-300 kbps
11. MODE 3 DATA RATE RESTRICTIONS[5] TOTAL I CHANNEL Q CHANNEL	 I(MAX) + Q(MAX) 1-300 kbps 1 kbps - 150 Mbps

Table 5-39. KSAR Service Signal Parameters (Continued)

B. DATA GROUP 2[1]	
1. CUSTOMER CARRIER FREQUENCY (F_2)	
COHERENT MODE (MODE 1)	$\frac{1600}{1469} \times F_R$
NONCOHERENT MODE (MODE 2)[8]	CUSTOMER SPACECRAFT OSCILLATOR
2. DATA FORMAT	
WITHOUT CONVOLUTIONAL CODING[6]	NRZ-L, NRZ-M, NRZ-S, Biϕ-L, Biϕ-M, Biϕ-S
WITH CONVOLUTIONAL CODING[4]	NRZ-L, NRZ-M, NRZ-S
3. DATA RATE RESTRICTIONS[5]	
TOTAL	1 kbps - 300 Mbps
I CHANNEL	1 kbps - 150 Mbps
Q CHANNEL	1 kbps - 150 Mbps
4. DATA MODULATION[7]	SQPSK, BPSK (SINGLE DATA CHANNEL), OR QPSK (DUAL DATA CHANNEL)

NOTES

[1]THE CUSTOMER SPACECRAFT DATA CONFIGURATION ARE DEFINED IN SECTION 5.3.2.3.2.3.

[2]F_R IS THE CARRIER FREQUENCY ARRIVING AT THE CUSTOMER SPACECRAFT; EXCEPT DURING SCHEDULED PERIODS OF DOPPLER COMPENSATION INHIBIT, $F_R = f_o \pm E$, WHERE f_o EQUALS THE NOMINAL CENTER FREQUENCY OF THE CUSTOMER SPACECRAFT RECEIVER AS DEFINED IN THE SCHEDULE AND $E = 500 \times \ddot{R}$ WHERE $\ddot{R} \leq 15 m/SEC^2$.

[3]Q CHANNEL PN CODE IS IDENTICAL TO I CHANNEL PN CODE OFFSET x + 1/2 PN CHIPS, WHERE $x \geq 20{,}000$. VALUE OF x IS DETERMINED BY PN CODE ASSIGNMENTS FOR A PARTICULAR CUSTOMER SPACECRAFT (~~STDN NO. 108~~451-PN CODE-SNIP).

[4]AT THE OPTION OF THE CUSTOMER, THE OUTPUT OF THE CONVOLUTIONAL ENCODER MAY BE NRZ TO Biϕ-L CONVERTED. THIS FORMAT CONVERSION CAPABILITY WILL ONLY BE UTILIZED WITH DATA RATES $\leq$ 5 Mbps. NO G_2 SYMBOL INVERSIONS WITHIN THE CONVOLUTIONAL ENCODER WILL OCCUR WHEN THE OUTPUT OF THE CONVOLUTIONAL ENCODER IS CONVERTED TO Biϕ-L FORMAT.

[5]DATA SIGNALS ON I AND Q CHANNELS MAY BE INDEPENDENT AND ASYNCHRONOUS. IF THE I AND Q CHANNEL DATA SIGNALS ARE INDEPENDENT, THE SUM OF THE DATA RATES ON THE I AND Q CHANNEL SHALL NOT EXCEED THE TOTAL MAXIMUM DATA RATE. FOR DATA GROUP 2 DUAL CHANNEL WITH IDENTICAL SYMBOL RATES ON THE I AND Q CHANNELS, THE I AND Q CHANNELS WILL BE OFFSET RELATIVE TO ONE ANOTHER BY ONE-HALF DATA BIT PERIOD OR, IF CONVOLUTIONALLY CODED, ONE-HALF ENCODED DATA SYMBOL PERIOD. FOR DG1 AND DG2, MAXIMUM DATA RATES FOR THE I CHANNEL, THE Q CHANNEL, AND THE TOTAL ARE REDUCED BY A FACTOR OF 2 WHEN DATA IS EITHER Bi-ϕ FORMATTED OR RATE ONE-HALF CONVOLUTIONALLY CODED. WHEN RATE ONE-HALF CONVOLUTIONAL CODING AND Bi-ϕ FORMAT CONVERSION ARE USED, THE MAXIMUM DATA RATES FOR THE I CHANNEL, THE Q CHANNEL, AND THE TOTAL ARE REDUCED BY A FACTOR OF 4 FOR DG1 AND DG2. Bi-ϕ DATA FORMAT WILL NOT BE USED FOR DATA RATES EXCEEDING 5 Mbps.

Table 5-47. MAR Service Signal Parameters (Cont'd)

6. PN CODE FAMILY	
MODE 1	TRUNCATED 18 STAGE SHIFT REGISTER SEQUENCES; PER ~~STDN 108~~451-PN CODE-SNIP
MODE 2	GOLD CODES; PER ~~STDN 108~~451-PN CODE-SNIP
7. SYMBOL FORMAT[4]	NRZ, Biϕ-L
8. DATA FORMAT	NRZ-L, NRZ-M, NRZ-S
9. DATA MODULATION	
MODES 1 AND 2	MODULO-2 ADDED ASYNCHRONOUSLY TO PN CODE ON EACH CHANNEL; SQPN
10. MODE 1 DATA RATE RESTRICTIONS[5]	
TOTAL	0.1 - 100 kbps
I CHANNEL	0.1 - 100 kbps
Q CHANNEL	0.1 - 100 kbps
11. MODE 2 DATA RATE RESTRICTIONS[5]	
TOTAL	1 - 100 kbps
I CHANNEL	1 - 100 kbps
Q CHANNEL	1 - 100 kbps

NOTES

[1]THE CUSTOMER SPACECRAFT DATA CONFIGURATIONS ARE DEFINED IN SECTION 5.3.2.3.3.3.

[2]F_R IS THE CARRIER FREQUENCY ARRIVING AT THE CUSTOMER SPACECRAFT; EXCEPT DURING SCHEDULED PERIODS OF DOPPLER COMPENSATION INHIBIT, $F_R = f_o \pm E$, WHERE f_o EQUALS THE NOMINAL CENTER FREQUENCY OF THE CUSTOMER SPACECRAFT RECEIVER AS DEFINED IN THE SCHEDULE AND $E = 70 \times \ddot{R}$ WHERE $\ddot{R} \leq 15$ m/SEC^2

[3]Q CHANNEL PN CODE IS IDENTICAL TO I CHANNEL PN CODE OFFSET x + 1/2 PN CHIPS, WHERE $x \geq 20{,}000$. VALUE OF x IS DETERMINED BY PN CODE ASSIGNMENTS FOR A PARTICULAR CUSTOMER SPACECRAFT (~~STDN 108~~451-PN CODE-SNIP).

[4]IF THE TRANSMITTED SYMBOL FORMAT IS NRZ-TO-Biϕ-L CONVERTED, THERE WILL BE NO G_2 INVERSION.

[5]DATA SIGNALS ON THE I AND Q CHANNELS MAY BE INDEPENDENT AND ASYNCHRONOUS. IF THE I AND Q CHANNEL DATA SIGNALS ARE INDEPENDENT, THE SUM OF THE DATA RATES ON THE I AND Q CHANNEL MUST NOT EXCEED 100 kb/SEC. IF THE I AND Q CHANNEL DATA SIGNALS ARE IDENTICAL AND SYNCHRONOUS (I.E., SINGLE DATA CHANNEL OPERATIONS), THE CHANNEL DATA RATE MUST NOT EXCEED 100 kb/SEC.

[6]MODE 2A DENOTES MODE 2 WHEN THE CUSTOMER SPACECRAFT OSCILLATOR FREQUENCY UNCERTAINTY IS LESS THAN ± 700 Hz; MODE 2B DENOTES THE CASE WHEN THE UNCERTAINTY IS LESS THAN ± 3 kHz.

5.3.2.3.3.2 Input Signal Characteristics

The signal characteristics of the received MAR signal shall be as specified below:

a. Input Power levels. The received isotropic power (customer signal plus customer-to-TDRS AWGN) from each element (averaged over the 30 element channels) at the SGLT Ku-band antenna will be as follows for clear sky conditions where the clear sky noise temperature is defined as 100°K:

   1. Maximum -139.09 dBmi per element.
   2. Minimum -165.09 dBmi per element.
   3. Nominal -152.09 dBmi per element.

The input signal may contain pulsed RFI with pulse widths up to 5 μs and pulse amplitudes up to 10 dB above the average received power. This input signal shall not cause damage or cumulative degradation to the SGLT equipment. The SGLT implementation shall not extend the effect of each pulse by more than 100 ns and shall provide for the operation of all signal processing functions, from RF to baseband, in the presence of pulsed RFI. Note: The P_E performance requirements of Section 5.3.2.3.3.6 do not apply to this input signal condition. The performance requirements of Section 5.3.2.3.3.6 apply at the nominal input power levels and not over the full range defined above.

b. Nominal Element Center Frequencies.

Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)
1	13405	16	13517.5
2	13412.5	17	13525
3	13420	18	13532.5
4	13427.5	19	13540
5	13435	20	13547.5
6	13442.5	21	13555
7	13450	22	13562.5
8	13457.5	23	13570
9	13465	24	13577.5
10	13472.5	25	13585
11	13480	26	13592.5
12	13487.5	27	13600
13	13495	28	13607.5
14	13502.5	29	13615
15	13510	30	13622.5